

this type of demonstration work, some communities have purchased equipment and now carry out their own mosquito abatement work.

In 1950, eight towns operated their own

programs, and cooperative projects on an experimental basis were carried out in eight towns by the Department of Entomology. Excellent results were achieved with a mist-blower using DDT emulsion.

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## ARTICLES

### TOXICITY OF SEVERAL ORGANIC INSECTICIDES TO ANOPHELINE LARVAE<sup>1</sup>

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During the last 5 years several thousand organic compounds have been screened at the Orlando, Fla., laboratory for toxicity to larvae of *Anopheles quadrimaculatus* Say. A great many of these compounds showed some degree of toxicity to this species, but only a few were sufficiently promising to warrant field testing as larvicides. Most of the better compounds have been available for several years and many mosquito control workers have tested them against various species. A review of the published information on various new compounds, together with some original data, was published by Travis and McDuffie (1950). Additional tests have now been run with most of the

better materials against the larvae of *A. quadrimaculatus* in the laboratory and against this species and *A. crucians* Wied in the field. Data from tests conducted in 1950 and 1951 are presented in this paper.

#### LABORATORY TESTS

Screening tests were conducted in the laboratory against fourth-instar *Anopheles quadrimaculatus*. The toxicants were first dissolved in acetone and then introduced into beakers of distilled water in the amounts necessary to give a range of concentrations. Distilled water was used to avoid the effects of suspended matter and dissolved chemicals that occur in other types of water. From 4 to 10 replications of 2 tests of 25 larvae each were made at a range of concentrations with each chemical. DDT was included as a standard of comparison in each series of tests and

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<sup>1</sup>This work was conducted under funds allotted by the Department of the Army to the Bureau of Entomology and Plant Quarantine.

mortalities were observed after 24 and 48 hours.

As shown in Table 1, parathion was the most toxic compound, closely followed by dieldrin, and both materials were considerably more effective than DDT. Toxaphene and chlordane were slightly less toxic than DDT. Dilan<sup>1</sup> and its components were the least toxic of the materials tested.

### FIELD TESTS

Field tests of the same compounds used in the laboratory tests were conducted on small plots 200 to 1,000 square feet in size. The plots were located in drainage ditches and roadside borrow pits that were generally choked with hyacinths, water lilies, and grass. The larval population consisted of all stages of *Anopheles crucians* and *A. quadrimaculatus*, with the former predominating. Larval populations were determined by dipping counts and averaged from 1.3 to 11.0 per dip in the plots before treatment. The effectiveness of the various dosages and materials was based on the reduction in larval counts 24 hours after treatment.

Most of the insecticides were tested at several dosages, both as oil solutions and emulsions. All treatments were applied with a small hand atomizer, which produced a very fine particle size, and at a standard rate of 5 pints per acre. Different dosages were obtained by varying the concentration of the insecticides in the sprays. From 3 to 10 replications were made with each dosage of insecticide. Results of the tests are summarized in Table 2.

Dieldrin was the most toxic of all the compounds tested, both as an oil solution and as an emulsion. It was slightly more effective than heptachlor, DDT, and parathion, which were about equal, and all were much more effective than toxaphene, aldrin, chlordane, or lindane. As in the laboratory tests, Dilan and its components were the least effective of the

compounds tested. Fuel oil alone on check plots caused considerable mortality in some cases, but on the whole was relatively ineffective at the rate at which it was applied (5 pints per acre).

In comparative tests with four materials—dieldrin, DDT, lindane, and toxaphene—all were more effective in emulsions than in oil solutions (Table 3). The difference was slight with dieldrin but rather marked with DDT, lindane, and toxaphene.

A comparison of the results of the laboratory and field tests showed that heptachlor was considerably more toxic in the field than in the laboratory. With parathion, the reverse was indicated. The remaining compounds showed about the same relative toxicity in the field as in the laboratory.

In 1946 other workers at the Orlando laboratory (unpublished report<sup>2</sup>) conducted similar small-plot tests with DDT, chlordane, TDE, toxaphene, benzene hexachloride (12 per cent gamma isomer), and methoxychlor, and the results are briefly summarized below. The materials were dissolved in No. 2 fuel oil and applied as mist sprays with a paint sprayer. All solutions were applied at the rate of 0.6 gallon per acre at concentrations of 0.63 and 1.25 per cent, to give dosages of 0.05 and 0.1 pound of toxicant per acre.

DDT was the most effective and methoxychlor the least effective material. The average per cent reductions of the larvae after 24 hours from five replications of each treatment were as follows:

	Dosage (Pound per acre)	
	0.05	0.10
DDT	89	99
Chlordane	65	95
TDE	59	86
Toxaphene	56	88
Benzene hexachloride (12 per cent gamma isomer)	66	56
Methoxychlor	34	48

<sup>1</sup> A 1:2 mixture of 1,1-bis-(*p*-chlorophenyl)-2-nitropropane and 1,1-bis-(*p*-chlorophenyl)-2-nitrobutane.

<sup>2</sup> Raun, E. S., Gilbert, I. H., and Deonier, C. C. Field tests of several insecticides as anopheline larvicides.

TABLE 1.—Comparative toxicity of 11 organic compounds in acetone suspensions to fourth-instar larvae of *Anopheles quadrimaculatus*.  
(Averages of 4 to 10 replications.)

Material	Percent mortality in 48 hours at indicated concentration in p.p.m.										LC-50 <sup>1</sup> (p.p.m.)	
	0.1	0.05	0.025	0.01	0.005	0.0025	0.001	0.0005	0.00025	0.000125	12	0.0006
Parathion	...	...	...	...	...	100	79*	48	...	...	...	0.0008
Dieldrin	...	...	...	...	100	91	62	...	...	...	...	0.0021
DDT	...	...	...	100	94	49	24	...	...	...	...	0.0027
Toxaphene	...	...	100	98	80	43	...	...	...	...	...	0.0028
Chlordane	...	...	...	100	68	54	...	...	...	...	...	0.004
Aldrin	...	...	100	82	67	34	...	...	...	...	...	0.008
Heptachlor	...	...	100	58	22	4	...	...	...	...	...	0.013
Lindane	...	100	58	48	13	...	...	...	...	...	...	0.026
1,1-Bis( <i>p</i> -chlorophenyl)-2-nitropropane	100	93	38	6	...	...	...	...	...	...	...	0.027
Dilan	97	77	39	12	...	...	...	...	...	...	...	0.036
1,1-Bis( <i>p</i> -chlorophenyl)-2-nitrobutane	96	52	26	6	...	...	...	...	...	...	...	...

<sup>1</sup> Determined from regression lines fitted to log-probability transformations, without use of weighting coefficients. For dieldrin the 50% point was obtained by extrapolation.

TABLE 2.—Results of field tests with emulsions and oil solutions of various larvicides against anopheline larvae.

	Percent mortality in 24 hours at indicated dosages (pound per acre)						
Material	0.1	0.05	0.025	0.0125	0.006	0.003	0.0015
<i>Emulsions</i>							
Dieldrin	...	...	...	98	98	98	96
Heptachlor	...	...	...	98	90	80	64
DDT	...	...	100	96	87	81	59
Toxaphene	...	...	...	93	84	82	...
Aldrin	...	...	99	88	83	86	53
Lindane	...	...	90	84	80	71	...
1,1-Bis( <i>p</i> -chlorophenyl)- 2-nitropropane	100	90	93	82	72	71	...
1,1-Bis( <i>p</i> -chlorophenyl)- 2-nitrobutane	93	88	88	77	73	65	39
Dilan	91	85	84	73	75	64	...
<i>Oil Solutions</i>							
Dieldrin	...	100	99	98	92	87	76
Parathion	...	...	...	92	79	67	66
DDT	...	98	96	95	79	57	56
Chlordane	...	93	88	64	...	...	...
Lindane	...	90	87	65	...	...	...
Toxaphene	...	86	63	62	...	...	...

TABLE 3.—Comparative toxicity of emulsions and oil solutions of dieldrin, DDT, lindane, and toxaphene to anopheline larvae in field tests.

Type of treatment	Percent mortality in 24 hours at indicated dosages (pound per acre)				
	0.025	0.0125	0.006	0.003	0.0015
<i>Dieldrin</i>					
Emulsion	..	98	98	98	96
Oil solution	99	98	92	87	76
<i>DDT</i>					
Emulsion	..	100	96	87	81
Oil solution	96	95	79	57	56
<i>Lindane</i>					
Emulsion	90	84	80	71	..
Oil solution	87	65	..	..	..
<i>Toxaphene</i>					
Emulsion	..	93	84	82	..
Oil solution	86	63	62	..	..

Fuel oil alone at dosages of 0.6 to 2.9 gallons per acre caused reductions of 46 to 87 per cent in 24 hours.

#### Literature Cited

- TRAVIS, B. V., AND McDUFFIE, W. C. 1950. Chemicals for use in mosquito control. *N. J. Mosquito Extermin. Assoc. Proc.*, 37:96-101.